

Raising capital with uncertainty

Overpricing initial public offering for science-based firms with multiple ties to the food and drug administration

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Abstract—I study the effect of indirect ties between the firm’s scientific advisory board members and the Food and Drug Administration advisory committees on underwriter prestige, underwriting fee, underpricing and the initial offering price range for firms pursuing highly uncertain opportunities. Prestigious underwriters compete to underwrite securities offered by firms connected to the regulator. This result in overpricing even though the underwriter seeks to enforce underpricing. The findings contribute to the Coase-Knight debate about the role of uncertainty for firm boundaries.

Keywords—uncertainty; pricing; firm-regulator ties

I. INTRODUCTION

Capitalizing on the entrepreneurial opportunities that one discovers is an essential element of the wealth creation process [1]. However, one of the major problems for any entrepreneurial venture is obtaining the resources to develop the opportunities it discovers and sustain its long term viability [2]. The underwriter helps the entrepreneurial firm to secure access to the investors. But it needs a reputation for pricing security issues fairly. The underwriter can price risks reasonably well because there is a known distribution of probabilities for risk events. But knightian uncertainty cannot be priced because there is no known distribution of probabilities for uncertain events. Because it is difficult to price uncertainty, bankers will seek out issuers that present less uncertainty for its institutional investors. Paradoxically, for firms engaged in technological discoveries where the future payoffs are uncertain, it is exactly this uncertainty that is the source of entrepreneurial profits. If the payoff is highly certain, competitors will all invest in the “right” technologies and compete the excess profit to zero [3]. Under this backdrop, how does the knightian uncertain firm convince the underwriter about the relative certainty of its valuation?

This paper investigates how the underwriter’s perceived uncertainty about the entrepreneurial firm, shaped by the number of indirect firm-regulator ties the issuer has, affect its assessment about the relative uncertainty of the firm’s valuation and the pricing of the Initial Public Offering. I study life science companies with scientific advisory boards (SABs) because the presence of scientific advisors suggests that these firms are still working on basic research and is characterized by a need for guidance amidst uncertainty [3, 4]. My sample is a subset of these science-based companies - issuers with SABs that launch IPOs from 1996 to 2006. The firm-regulator ties are institution-based ties between

members of a firm’s SAB and the Food & Drug Administration (FDA) scientific advisory committees.

I examine the effect of these ties for science-based companies in the IPO context because I want to address a basic question in the Coase-Knight debate about the role of uncertainty for firm boundaries. Coase [5] objected to Knight’s argument that firms are formed to bear the costs of uncertainty, arguing that specialized services for judgment under uncertainty are contractible in the market [6]. But there are strong theoretical reasons for why entrepreneurial judgment is non-contractible. Besides information asymmetry problems related to moral hazard and the Arrow information paradox, there is also the problem of ensuring that both parties to the transaction share the same judgment [6-10]. When the innovation belongs to an emergent category that is populated with only a few instances, there is insufficient knowledge to generate a distribution of probabilities to arrive at common judgment [3, 11]. Yet, we routinely observe firms seeking to capitalize on opportunities with highly uncertain future cash flows launch IPOs to raise equity capital.

I hypothesized that among high uncertainty firms, the firm with a significant number of ties to the regulator may be mislabeled as a low uncertainty firm by the underwriter. The erroneous categorization increases the contractibility of entrepreneurial judgment and facilitates resource flow from the investors to the entrepreneurial firm.

Underpricing is used to measure the investors’ willingness to commit resources to the entrepreneurial firm. All things being equal, the IPO proceeds are maximized if underpricing is minimized [12, 13]. The less underpriced a stock is, the greater the investor’s willingness to commit resources to the firm. By contrast, the ex-ante market value of each share is unknown so it is impossible to know whether a firm had maximized its IPO proceeds based on the amount of the capital raised.

The research design takes advantage of the institutional features embedded in the US IPO setting that produces underpricing to propose that the underwriter will overprice securities of firms with indirect ties to the regulator. Bankers engage in practices that set the IPO price lower than the market price; they also manage investors’ demand for the

security [14-20]. These activities set a floor for the security's price in the IPO aftermarket.

Despite the underwriter's control of the IPO environment and its tendency to underprice securities, I document a negative relationship between indirect firm-regulator ties and underpricing. *Ceteris paribus*, IPOs with more than twenty indirect firm-regulator ties are predicted to be priced progressively higher than the first-day closing prices.

The statistical estimates were derived from a three-stage least squares that include underpricing, underwriter prestige, underwriting fee, initial offering price range and the number of firm-regulator ties as correlated dependent variables. The ties are positively related to underwriter prestige and negatively related to underpricing, underwriting fee and initial offering price range. The results are robust to alternative econometric specifications.

The findings suggest the underwriter assumes that indirect access to the regulator can reduce valuation uncertainty for the focal firm. Because the firm-regulator ties are perceived as uncertainty reducing, prestigious underwriters compete to underwrite IPOs of firms indirectly connected to the regulator and end up overpricing the IPO in spite of the use of practices to enforce underpricing.

II. UNDERWRITING AND VALUATION UNCERTAINTY

Endorsements from a reputable underwriter reduce the investors' concerns with regard to the uncertainty of the entrepreneurial venture's value [4, 21]. Because the underwriter is an active player in the capital markets, it runs the risk of eroding its reputation capital when it makes pricing mistakes. The underwriter is obligated to both sides of the market – consistently overpricing the securities may erode the goodwill with the institutional investors and consistently underpricing the securities may deter prospective issuers [17]. Pricing mistakes can affect the underwriter's ability to bring new companies public in the future. Thus, the underwriter is motivated to preserve its reputation capital, which in turn provides assurance to investors about the valuations of the companies the underwriter endorses. In the IPO book building process, the lead underwriter in the syndicate first attempts to ascertain the future cash flow of the firm under various scenarios and then arrive at a filing range bounded by two potential offer prices – a high offer price and a low offer price. The underwriter gives the filing range to the institutional investors and asks them to provide feedback on the number of shares they are willing to buy and the price that they are willing to pay within the filing range [18, 22, 23].

III. HYPOTHESES DEVELOPMENT

To examine whether a firm discloses its indirect firm-regulator ties to the underwriter in order to allay concerns about valuation uncertainty and consequently attract endorsements from reputable underwriters, we examine four correlated dependent variables in the primary capital markets – underwriter prestige, underwriting fee, initial filing price range, and underpricing.

A. Underwriter Prestige and Underwriting Fee

Because the underwriter augments its reputation capital by underwriting high quality issues and rent out its reputation capital to new issuers going public, reputable underwriters should both charge higher fees and underwrite less risky issues [21, 24, 25]. But it is questionable whether financial intermediaries can process information about intangible assets for science-based and technology firms [26, 27]. I argue that when the future cash flows arising from the issuer's intellectual capital is fundamentally unknowable, the underwriter use firm-regulator ties as a reverse proxy for uncertainty. The private disclosure of the ties by the issuer help the underwriter economize on information processing costs – costs that could be infinitely high because the future cash flows of science-based and technology firms are knightian uncertain.

Since underwriters augment their reputation capital by underwriting high quality issues (i.e. accurate valuation), I expect the underwriters to compete for issuers with multiple indirect firm-regulator ties. Having multiple ties to the regulator is important if the underwriters believe that indirect influence is fraught with difficulties. The gatekeeper, by virtue of his or her independence, can refuse to cooperate [28]. But a firm can gain access to the regulator via alternative networks by building multiple indirect ties [29]. This means that bankers may expect firms with more ties to have better access to the regulator. Therefore, I argue that firms with multiple indirect firm-regulator ties will attract the endorsements of more reputable underwriters and yet pay a lower underwriting fee. I state the hypotheses as follows:

H1: The number of firm-regulator ties is positively related to the underwriter's prestige score

H2: The number of firm-regulator ties is negatively related to the underwriting fee.

B. Underpricing and Range

To further establish the proposition that underwriter view the indirect firm-regulator ties as uncertainty-reducing, I examine the relationship between the ties and underpricing. There are several institutional features embedded in the IPO setting that enforce underpricing. This creates a natural experimental context for the study. Specifically, even if underpricing and uncertainty is positively correlated [17, 30], firms with relatively certain valuations should still be underpriced. The underwriter has recurring relationships with institutional investors but only temporary relationships with each IPO firm [13]. Therefore, the underwriter supply investors with underpriced stock to encourage demand for IPO deals in the future and cultivate loyalty among institutional investors [31, 32]. When the underwriter discovers stronger demand for the shares than the quantity available, the underwriter only adjusts the supply of shares and the offer price partially [15, 16]. The book-building process intentionally creates excess demand for issuers' shares and reduces the likelihood for under-subscription [23]. Furthermore, by underpricing the IPO, the underwriter reduces the need to stabilize prices in the aftermarket [14].

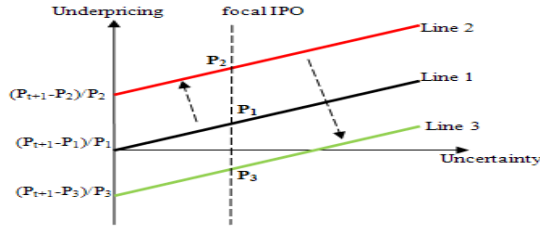


Figure 1. Underpricing and Uncertainty

The preceding analyses suggest a logic that is delineated in Fig. 1 below. P_1 , P_2 and P_3 refer to the IPO prices in three different scenarios. P_{t+1} is the first-day closing price. The broken vertical line holds uncertainty constant for the focal IPO. Line 1 provides the relationship between underpricing and uncertainty if underpricing is strictly a premium for uncertainty. In this case, there would be no underpricing if there is no uncertainty. Line 2 provides the relationship between underpricing and uncertainty when the underwriter has additional incentives for underpricing IPOs. The broken arrow reflects the upward shift from line 1 to line 2, indicating that the underwriter will underprice the IPO even if there is no uncertainty. Line 3 provides the relationship between underpricing and uncertainty when the underwriter misperceived that firm-regulator ties are uncertainty-reducing and the underwriter actually overpriced the IPO. The broken arrow reflects the downward shift from line 2 to line 3, indicating that the focal IPO price is actually higher than the first-day closing price even though there is uncertainty about the issuer's valuation.

A final piece of corroborating evidence would be the presence of a negative relationship between the initial offering price range and the number of firm-regulator ties. The reason is that lower valuation uncertainty also implies that there is a narrower range of valuation outcomes [16]. Overall, I state the hypotheses as follows:

H3: The number of firm-regulator ties is negatively related to underpricing

H4: The number of firm-regulator ties is negatively related to the initial offer price range

IV. RESEARCH DESIGN

Prior research suggests that it is not appropriate to sample firms of high and low uncertainties together [4]. Because the presence of advisors suggests a need for guidance amidst uncertainty [3], I sample 93 life science firms with scientific advisory boards. The IPOs are firm commitment offerings with the overallotment option. They are issued from 1996 to 2006 as common stock on the NASDAQ stock exchange. Prospectuses were downloaded from the SEC Edgar and data coded accordingly. Additional data came from a variety of sources including the FDA website, Pubmed, the Center for Measuring University Performance, United States Patents and Trademarks Office (USPTO), and the Securities Data Company (SDC) database.

A. Variables

Rank is the underwriter prestige score based on the Carter-Manaster ranking methodology, which uses the

investment banks' positions in the tombstone announcements to calculate their prestige scores. *Fee* is the gross payment made to the underwriter divided by the IPO proceeds. *UP* is the difference between the first-day closing price and the offer price with the difference divided by the offer price. *Range* is the difference between the upper bound and the lower bound of the initial price range provided by the underwriter to the institutional investors normalize by the midpoint of the range. *Freg* is the number of firm-regulator ties.

To calculate *Freg*, I code network information from the institutional affiliations of the SAB scientists and the FDA advisory committee members. The network data is used to construct an affiliation matrix. As shown in equation (1), I multiply it with its transpose to generate indirect networks.

$$Event = A^T A = \begin{bmatrix} a & d & g \\ b & e & h \\ c & f & j \end{bmatrix} \begin{bmatrix} a & b & c \\ d & e & f \\ g & h & i \end{bmatrix} \quad (1)$$

I then focus on the ties that each firm has to the FDA and use the count of the ties to construct a measure of the firm-regulator relationship. Each firm-level observation about the number of ties is statistically independent because this is a measure of firm-regulator ties rather than inter-firm ties.

Alliance is the total number of alliances a firm has with other organizations (both business and research organizations) at the time of the IPO. *Drug* is a dummy variable that takes on a value of 1 if the firm is in a core biotechnology field like therapeutics (i.e. drugs) and 0 otherwise. *Loc* is a dummy variable that takes on a value of 1 if the firm is located in San Diego, San Francisco or Boston. *VC* is a dummy variable that takes on the value of 1 if a firm is backed by venture capitalists and 0 if otherwise. *Firmage* is the difference between the founding date and the IPO date and is rescaled in years. *Lnasset* is the natural log of assets, which were originally measured in millions of dollars. *Lnemp* is the natural log of the number of employees. I control for *Periodic effects* with the Nasdaq Biotechnology Index, year dummies, and a stock bubble dummy.

Update refers to the percentage change from the midpoint of the initial offering price range to the final offer price (OP).

$$Update = \left[OP - \frac{P_L + P_H}{2} \right] / \left[\frac{P_L + P_H}{2} \right] \quad (2)$$

This is shown in equation (2) above where P_L and P_H are the lower and upper bounds of the initial offering price range respectively.

USUP refer to underwriter-specific underpricing, which is calculated as the moving average of the actual initial returns of IPOs underwritten by the focal underwriter minus market-wide averages for the same period [33]. This measure controls for underwriter selection. Because of the institutional features embedded in the IPO setting, the firm's ability to reduce underpricing is largely a function of underwriter selection. If the CEO is dissatisfied with the

IPO price after book-building, his options are limited to reducing the shares sold or withdrawing the IPO. Selecting a low underpricing underwriter should be an outcome of strong monitoring effort. The persistence of underwriter-specific underpricing is a visible reflection of the underwriter's market power. That is, the CEO can reduce underpricing by selecting a low underpricing underwriter. *USUP* substitutes for corporate governance variables that proxy for the strength of monitoring mechanisms. Experienced inside board members bonded with substantial equity holdings may prevent excessive underpricing by selecting a low underpricing underwriter. But there are reverse causality problems in using board characteristics and executive compensation to proxy for the strength of monitoring mechanisms [13, 34, 35]. For example, vesting directors with more equity ownership may enhance monitoring. But a firm may have awarded more salary and less equity because the firm presents comparatively more risk for the directors. Likewise, responsible inside directors may engage in monitoring activities. But the presence of more outside directors may be due to the ineffectiveness of inside directors in monitoring in a prior period. Therefore, we cannot easily infer monitoring from governance variables.

Sabsize is the count of the number of SAB members. *Rdspend* is standard deviation of the SAB member institutions research expenditure. *Sdpub* is the standard deviation of the SAB members' average annual publications. *Npat* is the number of patents that the firm has on the IPO date. *Scitmt* is the number of senior executives with scientific doctorates. *Pipe* is the number of products that the firm is developing.

B. Econometric specifications

The major dependent variables are correlated; there are non-recursive relationships in the equations and the endogeneity of the firm-regulator networks need to be accounted for. Running a seemingly unrelated regression [SUR] allow the disturbances to be correlated and improves the estimates. But I also need to use the residuals from the two-stage least squares (2SLS) to obtain an estimate of the error variance-covariance matrix in the third stage, applying the generalized least square (GLS) technique. This yields a three-stage least squares (3SLS) equation, which combines the 2SLS and the SUR. Specifically, I specify a system of structural equations connecting M jointly dependent and A exogenous variables:

$$D_i = Y_i \gamma_i + X_i \beta_i + u_i = Z_i \delta_i + u_i ; \quad Z_i = (Y_i, X_i) ; \quad \delta_i = \begin{pmatrix} \gamma_i \\ \beta_i \end{pmatrix} \quad (3)$$

where D_i is a column vector of T observations on the jointly dependent variable to be predicted in the i th equation and $i = (1, 2, \dots, M)$. Further, Y_i is the $T \times m_i$ matrix of values on m_i ($< M$) jointly dependent variables of the i th equation and y_i is the corresponding coefficient vector. And X_i is the $T \times k_i$ matrix of values on k_i ($< A$) exogenous variables of the i th equation and β_i is the corresponding coefficient vector. Finally, μ_i is a column vector of T structural disturbances with $E(\mu_i) = 0$ and $E(\mu_i \mu_j') = \sigma_{ij} I_T$, bounded by $(i, j = 1, \dots, M)$.

Similar to the SUR, the 3SLS also rely on correlated residuals to maximize efficiency of the estimates - the greater the correlation of the disturbances, the greater the efficiency gain. In the limit, GLS brings no efficiency gain over the OLS in two situations. First, when the explanatory variables in one equation are a subset of another equation, there is no efficiency gained in the smaller equation. Second, when the explanatory variables in different equations are nonsingular, linear combinations of the same set of variables, OLS and GLS are identical. Because such equations yield only equation-specific disturbances, there is no efficiency gained over OLS.

Therefore, I adopt a modeling strategy that ensures the equations are specified differently. In cases where I desire to control for the same phenomenon (for example, quality of the firm's science), I use different proxy variables in the equations. Ideally, the different proxy variables should also have reasonably low correlations with each other so that sufficient common variances are captured in the covariance matrix of disturbances. Paradoxically, this also means that equation-specific disturbances are likely to be orthogonal to *Freg* because it is common to four equations. Finally, I use the t -distribution instead of the z -distribution to compute the test statistics because of the small sample size.

V. RESULTS

Table 1 report means and standard deviations between the independent variables. Due to space constraints, the distribution for the dependent variables and the correlation matrix are not reported. However, these results are available upon request.

Table 1: Descriptive statistics (N = 93 firms)

Variable	Mean	S.D.	Min	Max
USUP	6.74	4.23	-11.6	16.55
Alliances	2.89	2.69	0	19
VC	0.87	0.34	0	1
Sabsize	8.34	3.72	1	27
Sdpub	2.59	1.42	0.23	9.69
Rdspend	68338	33617	14279	212398
Scitmt	2.85	1.78	0	8
Patents	12.08	19.22	0	104
Pipe	7.06	4.42	1	27
Firmage	6.14	4.12	1.3	23.8
Lnasset	3.2	1.01	0.31	5.7
Lnemp	4.32	0.8	1.61	6.4
Loc	0.35	0.48	0	1
Drug	0.76	0.43	0	1
Update	-0.14	0.27	-0.58	0.71

Table 2 report the initial statistical results from the system of equations. *USUP* is positively associated with *Fee* and *UP*. *VC* is negatively related to *Rank* and *UP* with statistical significance. *Drug* negatively predicts *Rank*. *Patents* positively predict *Fee*. In additional analyses, I include a variable on the product stage that the firm is in but the results are statistically insignificant. *Lnasset* positively predicts *UP* and *Rank*. *Loc* positively predicts *Rank*. Overall, results on the control variables add to the mixed evidence on science-based IPOs [4, 36, 37].

Table 2 (N = 93): The effects of firm-regulator ties on valuation uncertainty

	Rank	Fee	UP	Range	Freg
Intercept	6.669***	0.174	10.98	0.152***	-4.829
Freg	0.101***	-0.0878*	-2.371***	-1.14x10 ⁻³ **	
Rank		0.569			
USUP		0.159**	3.560***		
Update			42.00**		
Alliances	0.0102		1.734	8.06x10 ⁻⁴	
VC	-1.011*		-26.23*		3.533
Sbsize					1.586***
Sdpub					-0.412
Rdspend					1.27x10 ⁻⁵
Scitmt	0.0538				-1.605***
Patent		0.0293*		-1.04x10 ⁻⁴	
Pipe			-0.401		
Firmage	-8.25x10 ⁻³	-0.0827	-0.741	5.04x10 ⁻⁴	
Lnasset	0.375*		9.205*		2.527**
Lnemp		0.503		6.57x10 ⁻³	
Loc	0.615*				-4.833**
Drug	-0.774*				
Periodic effects	Included	Included	Included	Included	Included
R-Square	0.111	0.187	0.501	0.045	0.481
F-Stat	3.31	5.07	7.38	2.64	11.28

Unstandardized regression coefficients reported
Two-tail tests, *** p<0.001, ** p<0.01, * p<0.05

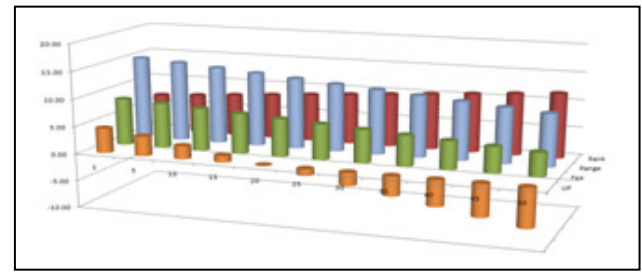
However, the results relating to *Freg* unanimously support the hypotheses. *Freg* is positively related to *Rank* and negatively related to *Fee*, *Range* and *UP*.

A. Robust analyses

To account for the possibility that there is a latent variable composed of the TMT's academic connections to research organizations that is highly correlated with firm-regulator ties and may affect underwriter prestige, I use instrumental analyses to split the ties into predicted TMT ties attributed to the number of PhD holders in TMT and the residual firm-regulator ties. In additional analyses, I ran the set of regressions with the predicted TMT ties replacing the number of PhD holders in the TMT and the residual firm-regulator ties replacing the number of firm-regulator ties. The results remain qualitatively unchanged.

In additional analyses, I also account for the presence of Nobel laureates, the number of prominent scientists that the firm has and outlier values. In all these cases, the results for the hypotheses remain qualitatively unchanged.

Overall, the linkages among the hypotheses ensure that the hypotheses are highly falsifiable. If the argument about uncertainty is false, not only would one or more of the hypotheses be unsupported. More importantly, we would not observe the opposite directions for the hypothesized relationships – a positive relationship between the ties and underwriter's reputation but a negative relationship between the ties and the price-related dependent variable (i.e. underwriting fee, price range and underpricing). In particular, we should not expect to see the underwriters fail to enforce the underpricing equilibrium.

Figure 2. Predicted values based on *Freg*

However, as shown in fig 2, the trend for the predicted values show that the expected closing price falls progressively below the expected offer price when there are more twenty indirect ties. This results in overpricing.

VI. CONCLUSION

Theoretically, firms seeking to capitalize innovations that are knightian uncertain should not be able to contract out entrepreneurial judgment. The only possible exception is when there is a matching continuum of entrepreneurs and investors such that every entrepreneur can find multiple investors who share his entrepreneurial judgment but instead of starting the venture, invest limited funds in the entrepreneur's start-up [10]. With regard to technological uncertainty, such situations are very limited even when applied to specialized angel investors and venture capitalists. Yet, we observe science-based companies selling securities in primary capital markets where both the underwriter and the investors are uncertain about the issuer's future technological prospects. Therefore, I question how the underwriter determine the issuer's valuation when its future cash flows are knightian uncertain.

This paper show that the contractibility of entrepreneurial judgment increases when the underwriter misclassify the high uncertainty firm that has a significant number of firm-regulator ties as a low certainty firm. The theoretical implication is that it is possible to contract entrepreneurial judgment even when the firm does not fall into a category with a known distribution of probabilities. This solves the intertwined problem of acquiring external capital and sustaining unique profits.

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